AUDIO WATERMARKING FOR CALL IDENTIFICATION IN A TELECOMMUNICATIONS NETWORK

Field

The present inventive subject matter relates to the telecommunication arts. Particular application is found in conjunction with Internet Protocol (IP) telephony, and the specification makes particular reference thereto. However, it is to be appreciated that aspects of the present inventive subject matter are

5 also amenable to other like applications.

Background

It is a common practice to use packet-switched networks, such as IP networks, to connect calls (e.g., voice, data or multimedia calls) between end users. For example, Voice over IP (VoIP) has been developed to permit

10 Consumer Premises Equipment (CPE), such as IP telephones, to be connected over an IP network so that end users may exchange voice communications via the connected CPE. Moreover, IP gateways have been developed that bridge IP networks with the Public Switch Telephone Network (PSTN), a circuit-switched network as opposed to a packet-switched network. That is to say, an

15 IP gateway acts as a point of entry for IP calls into the PSTN, e.g., via a telephone switch such as a class 5 switch, and vice versa for calls from the PSTN into the IP network.

Commonly, IP gateways take advantage of the class 5 switch's features to perform call processing, e.g., routing calls. With reference to FIGURE 1,

20 when a VoIP call is placed from an IP telephone 10 (i.e., the calling party), the call is routed over an IP network 12 and through an IP gateway 14 where it enters the PSTN 20, e.g., via a class 5 switch 22. This represents a first half-call as it is sometimes referred to in the art, indicated by arrow 30. The class 5 switch 22 then routes the call to the intended recipient. While generally the call

may in practice be intended for any CPE (including those accessible through the PSTN **20**), for the purposes of this example, the intended recipient of the call is another IP telephone **40** (i.e., the called party). Accordingly, to connect the call, it is routed back through the IP gateway **14** across the IP network **12** to

5 the IP telephone **40**. This represents a second half-call, indicated by arrow **32**, that along with the associated first half-call **30** completes the connection between the CPE, i.e., the IP telephones **10** and **40**.

With respect to the call in the aforementioned example, certain potential limitations, drawbacks and/or problems are revealed. For example, resources

10 of the switch **22** have to be utilized to maintain support of the call for the duration of its connection through the switch **22**. Similarly, resources of the IP gateway **12** also have to be continually utilized (i.e., during the calls duration) to convert and/or translate a packet-switched call to a circuit-switched call (for the first half-call **30**) and then ultimately to convert and/or translate the circuit-

15 switched call back into a packet-switched call (for the second half-call **32**). Accordingly, in such instances, it may at times be deemed advantageous to free the switch **22** from the burden of supporting the call. It may at times also be deemed advantageous to reduce the conversion/translation load carried by the IP gateway **14**, thereby relieving some of the burden thereon.

20 Accordingly, a new and improved system, gateway and/or technique is disclosed that overcomes the above-referenced problems and others.

Summary

In accordance with one preferred embodiment, a method of processing half-calls each having opposing first and second ends is provided within a

25 telecommunications network. Each of the half-calls is one of an originating half-call terminated at the first end thereof by calling consumer premises equipment and a terminating half-call terminated at the first end thereof by called consumer premises equipment, wherein an associated pair of half-calls connected at their second ends including both an originating and terminating

30 half-call completes a call connecting the consumer premises equipment terminating the respective first ends of the half-calls that form the pair. The method includes: (a) applying identifiers to originating half-calls such that the

originating half-calls are distinctly identifiable thereby with respect to one another, the identifiers thereafter accompanying terminating half-calls that form associated pairs of half-calls together with the originating half-calls to which the identifiers were applied; and, (b) examining terminating half-calls to detect the identifiers such that upon detection of the identifiers the terminating half-calls accompanying the detected identifiers and the originating half-calls to which the identifier were applied are recognized as associated pairs of half-calls.

In accordance with another preferred embodiment, a call processing apparatus for processing half-calls each having opposing first and second ends is provided within a telecommunications network. Each of said half-calls is either an originating half-call terminated at the first end thereof by calling consumer premises equipment or a terminating half-call terminated at the first end thereof by called consumer premises equipment, wherein an associated pair of half-calls connected at their second ends including both an originating and terminating half-call completes a call connecting the consumer premises equipment terminating the respective first ends of the half-calls that form the pair. The call processing apparatus includes: application means for applying identifiers to originating half-calls such that the originating half-calls are distinctly identifiable thereby with respect to one another, the identifiers thereafter accompanying terminating half-calls that form associated pairs of half-calls together with the originating half-calls to which the identifiers were applied; and, examination means for examining terminating half-calls to detect the identifiers such that upon detection of the identifiers the terminating half-calls accompanying the detected identifiers and the originating half-calls to which the identifier were applied are recognized as associated pairs of half-calls.

In accordance with yet another preferred embodiment, a gateway is provided in a telecommunications network including a packet-switched network and a circuit-switched network. The gateway bridges the packet-switched and circuit-switched networks with one another by selectively converting packet-switched calls into circuit-switched calls and vice versa depending on a direction of traffic flow over the gateway. The gateway includes: an audio watermark generator that applies identifiers to a first leg of calls routed through

the gateway, the identifiers distinctly identifying the respective calls to which they are applied from one another; and, an audio watermark sensor that examines a second leg of calls routed through the gateway to detect for identifiers.

5   Numerous advantages and benefits of the inventive subject matter disclosed herein will become apparent to those of ordinary skill in the art upon reading and understanding the present specification.

Brief Description of the Drawings

         Preferred embodiments may take form in various components and
10   arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating preferred embodiments and are not to be construed as limiting. Further, it is to be appreciated that the drawings are not to scale.

         FIGURE 1 is a block diagram showing a conventional
15   telecommunications system employing a VoIP gateway.

         FIGURE 2 is a block diagram showing a telecommunications system including an IP gateway in accordance with an exemplary embodiment thereof.

         FIGURE 3 is a flow chart showing a process for handling originating half-calls in accordance with an exemplary embodiment of the process.

20   FIGURE 4 is a flow chart showing a process for handling terminating half-calls in accordance with an exemplary embodiment of the process.

Detailed Description of Preferred Embodiments

         For clarity and simplicity, the present specification shall refer to structural and/or functional network elements, entities and/or facilities, relevant
25   communications standards, protocols and/or services, and other components that are commonly known in the telecommunications art without further detailed explanation as to their configuration or operation except to the extent they have been modified or altered in accordance with and/or to accommodate the preferred embodiment(s) presented.

30   With reference to FIGURE 2, an exemplary telecommunications system is illustrated in accordance with a preferred embodiment. The operation of the

system shall be described by way of an exemplary IP call initiated from calling CPE **60** to called CPE **90**. For illustrative purposes, CPE **60** and **90** are shown as IP telephones, e.g., involved in a VoIP call. However, it is to be appreciated that the CPE **60** and **90** may be any appropriate type of CPE as is known in the

5   art for conducting various types of IP or packet-switch calls, e.g., voice, data, multimedia, etc. Further, it is to be appreciated that while only one particular call between a pair of CPE (i.e., the calling and called CPE **60** and **90**) is shown, a plurality of such calls are similarly being handled simultaneously between a plurality of likewise situated calling and called CPE.

10   As shown, the CPE **60** and **90** are operatively connected to an IP network **62**, or another like packet-switched network, so that end users employing the same may exchange communications with one another. An IP gateway **64** bridges the IP network **62** with the PSTN **70**. That is to say, the IP gateway **64** acts as a point of entry for packet-switched calls from the IP

15   network **62** headed into the PSTN **70**, and similarly acts as a point of entry for circuit-switched calls from the PSTN **70** headed into the IP network **62**. In the usual manner, the IP gateway **64** selectively converts and/or translates packet-switched calls into circuit-switched calls and vice versa depending on the direction of traffic flow.

20   Suitably, a class 5 switch **72**, or other suitable circuit-switched telecommunications switch, on the PSTN side of the IP gateway **64** interfaces with the IP gateway **64**, e.g., via a GR-303 interface **74**, or another like interface such as a V.5.2 interface. Use of the GR-303 interface **74**, the V.5.2 interface or the like, is advantageous insomuch as from the perspective of the

25   switch **72** the IP gateway **64** acts and/or otherwise appears as a remote digital terminal (RDT) while continuing to appear from the IP side as a gateway into the PSTN **70**. The switch **72** is responsible for call routing and optionally provides other call processing and/or call features normally associated therewith.

30   For example, when a call is placed from the calling CPE **60**, the call is routed over the IP network **62** to the IP gateway **64** where it is translated from a packet-switched call to a circuit-switched call. The call then enters the PSTN **70** via the switch **72** (which may be considered part of the PSTN **70**). This

represents a first leg of the complete call or an originating half-call (indicated by the combination solid/dashed arrow **80**).

The switch **72** then routes the call to the intended recipient. Accordingly, in this example, the call is routed, again via the GR-303 interface **74**, back to the IP gateway **64** where the circuit-switched call is translated back into a packet-switched call. Finally, the call is directed over the IP network **62** to the CPE **90**. This represents a second leg of the complete call or a terminating half-call (indicated by the combination solid/dashed arrow **82**) that along with the associated originating half-call **80** completes the connection between the CPE **60** and **90**.

Suitably, the IP gateway **64** includes an Audio WaterMark (AWM) generator **66** and an AWM sensor **68**. The AWM generator **66** operates on half-calls passing through the gateway **64** from the IP network **62** to the PSTN **70**, e.g., in this case the first or originating half-call **80**, and the AWM sensor **68** operates on half-calls passing through the gateway **64** from the PSTN **70** to the IP network **62**, e.g., in this case the second or terminating half-call **82**.

More specifically, when the originating half-call **80** reaches the gateway **64**, the AWM generator **66** generates and applies an AWM thereto that uniquely identifies the originating half-call **80**. Suitably, the AWM is an encoded signal, e.g., superimposed on the traffic of the originating half-call **80**, that is substantially unperceivable by and/or inaudible to end users employing the CPE **60** and/or **90**, but nevertheless detectable. For example, a suitable AWM may be achieved by encoding a low frequency, low intensity signal with some unique identifying data or low bit rate information. However, other suitable types of substantially hidden audio watermarking techniques as may be known in the art are also contemplated.

When the terminating half-call **82** reaches the gateway **64**, the AWM sensor **68** analyzes and/or examines the same to detect the accompanying AWM. Accordingly, the terminating half-call **82** is recognized as corresponding to the originating half-call **80**. Of course, it is to be appreciated that a plurality of various originating and terminating half-calls are likely being routed through the gateway **64** at any given time. For example, a call may be made from CPE (situated similar to CPE **60**) to CPE **76**, e.g., a regular or non-IP telephone, that

is connected to the PSTN **70**. Accordingly, the originating half-call from the IP network **62** passes through the IP gateway **64**, but there is no corresponding terminating half-call that passes through IP gateway **64**, rather the corresponding terminating half-call is routed over the PSTN **70** to the CPE **76**.

5 Likewise, for a call originating from the CPE **76** to CPE situated similar to CPE **90**, the IP gateway **64** has a terminating half-call passing therethrough with no corresponding originating half-call passing therethrough. Furthermore, there may be numerous distinct calls having both their originating and terminating halves passing through the gateway **64**. Nevertheless, the audio watermarking

10 provides a way to distinguish the identity of originating and terminating half-calls passing through the gateway **64** that correspond to and/or are otherwise associated with one another.

Suitably, once the half-calls **80** and **82** are recognized as corresponding to one another, the solid arrow or packet-switched portions of the half-calls **80**

15 and **82** are directly connected to one another. In essence, the PSTN **70** is bypassed by short circuiting the call at the IP gateway **64**. Accordingly, the switch **72** is no longer involved in the call once the connection is completed. That is to say, the call routing path represented by the dashed arrow or circuit-switched portions of the half-calls **80** and **82** is no longer employed so as to

20 relieve the switch **72** of having to support the call for its entire duration. Additionally, the load on the IP gateway is also lessened insomuch as the packet-switched portion of the first half-call **80** is connected directly with the packet-switched portion of the second half-call **82**. That is to say, once the connection is completed, the IP gateway **64** no longer has to convert or

25 translate the originating half-call **80** from a packet-switched call to a circuit-switched call, nor convert or translate the terminating half-call **82** back from a circuit-switched call to a packet-switched call. In fact, having connected the packet-switched portions of the half-calls **80** and **82** directly with one another, the IP gateway **64** is also optionally released from the call entirely, i.e., the call

30 is optionally connected between the CPE **60** and CPE **90** over the IP network **62** without passing through the gateway **64**. For example, one or both of the CPE involved in the call are optionally provided with the other's IP address, or

the like, so that they may connect directly with one another over the IP network **62** (i.e., without passing through the gateway **64**).

      With reference to FIGURE **3**, an exemplary process for handling originating half-calls within the IP gateway **64** is illustrated. At step **100**, the
5   gateway **64** receives an originating half-call from the IP network **62**. At step **102**, the received originating half-call is converted or translated into a circuit-switched call. At step **104**, a uniquely identifying AWM is applied to the received half-call, e.g., via the AWM generator **66**, and information or data corresponding to the applied AWM is stored, e.g., in an AWM DataBase (DB)
10   **69** (see FIGURE **2**). Suitably, the AWM DB **69** relates each particular applied AWM to the respective half-call it identifies. At step **106**, the audio watermarked half-call is directed to a circuit-switched telecommunications switch (e.g., the switch **72**) for routing.

      With reference to FIGURE **4**, an exemplary process for handling
15   terminating half-calls within the IP gateway **64** is illustrated. At step **200**, the gateway **64** receives a terminating half-call from the PSTN **70**, e.g., via switch **72**. At step **202**, the received terminating half-call is analyzed and/or examined to detect and/or identify any accompanying AWM, e.g., via the AWM sensor **68**. At step **204**, the received half-call is converted or translated into a packet-
20   switched call. At decision step **206**, it is determined if the detected AWM (if any) from the received half-call matches a previously applied AWM. Suitably, if an AWM is detected, it is compared against those stored in the AWM DB **69** to determine if a match exists and/or to identify the other half-call to which the particular AWM was applied. If no match exists (including, if no AWM was
25   detected), then the process continues to step **208** where the received terminating half-call is directed over the of the IP network **62** to the called CPE. On the other hand, if a match does exist, then a corresponding pair of half-calls has been recognized and the process continues to step **210** where the received terminating half-call is connected to the identified originating half-call having the
30   matching AWM. Thereafter, the process continues to step **208** such that the identified originating half-call is connected over the IP network **62** to the called CPE (e.g., as represented by the solid arrow portions of half-calls **80** and **82**).

With regard to FIGURES **2, 3** and **4**, the application and detection of the AWM is shown and described above as occurring while the respective half-calls are in their circuit-switched states. However, the application and detection of the AWM is optionally carried out in a similar manner while the respective half-calls are in their packet-switched states. For example, steps **102** and **104** may be transposed and steps **202** and **204** may be transposed.

For simplicity and clarity, only a single switch **72** and a single gateway **64** have been shown in FIGURE **2** and described above. It is to be appreciated, however, that a plurality of similarly situated network elements operating in like manner optionally exist within the system. Moreover, for some calls, the originating and terminating half-calls may be routed through different switches and/or gateways. For example, an originating half-call from a calling CPE may be directed over the IP network **62** to an originating gateway and on to an originating switch. However, due to the call's destination, it may then be routed over the PSTN **70** to a terminating switch (different than the originating switch) which directs a terminating half-call to a terminating IP gateway (also different than the originating gateway), and then over the IP network **62** to the called CPE. Suitably, in such instances, the originating gateway communicates to the terminating gateway the AWMs applied by the originating gateway and information regarding the half-calls they identify so that the terminating gateway upon detecting an AWM in a terminating half-call is able to establish the identity of the terminating half-call's corresponding originating half-call. For example, the AWM DB **69** is optionally maintained on a DB server or the like connected to the IP network **62** so as to be accessible to all the IP gateways in the system. Accordingly, the relevant information and/or data regarding any AWM applied by any originating gateway is stored therein so as to be accessible by any terminating gateway that detects an AWM. Accordingly, a corresponding originating and terminating half-call pair is recognizable regardless of whether or nor they are passing through the same gateway. Suitably, once they are so recognized, they are directly connected to one another within the IP network **62** thereby bypassing the PSTN **70** entirely and optionally bypassing one or both of the originating and terminating gateways.

It is to be appreciated that in connection with the particular exemplary embodiments presented herein certain structural and/or function features are described as being incorporated in defined elements and/or components. However, it is contemplated that these features may, to the same or similar benefit, also likewise be incorporated in other elements and/or components where appropriate. It is also to be appreciated that different aspects of the exemplary embodiments may be selectively employed as appropriate to achieve other alternate embodiments suited for desired applications, the other alternate embodiments thereby realizing the respective advantages of the aspects incorporated therein.

It is also to be appreciated that particular elements or components described herein may have their functionality suitably implemented via hardware, software, firmware or a combination thereof. Additionally, it is to be appreciated that certain elements described herein as incorporated together may under suitable circumstances be stand-alone elements or otherwise divided. Similarly, a plurality of particular functions described as being carried out by one particular element may be carried out by a plurality of distinct elements acting independently to carry out individual functions, or certain individual functions may be split-up and carried out by a plurality of distinct elements acting in concert. Alternately, some elements or components otherwise described and/or shown herein as distinct from one another may be physically or functionally combined where appropriate.

In short, the present specification has been set forth with reference to preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the present specification. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

What is claimed is: